INDUSTRIAL METALLURGY

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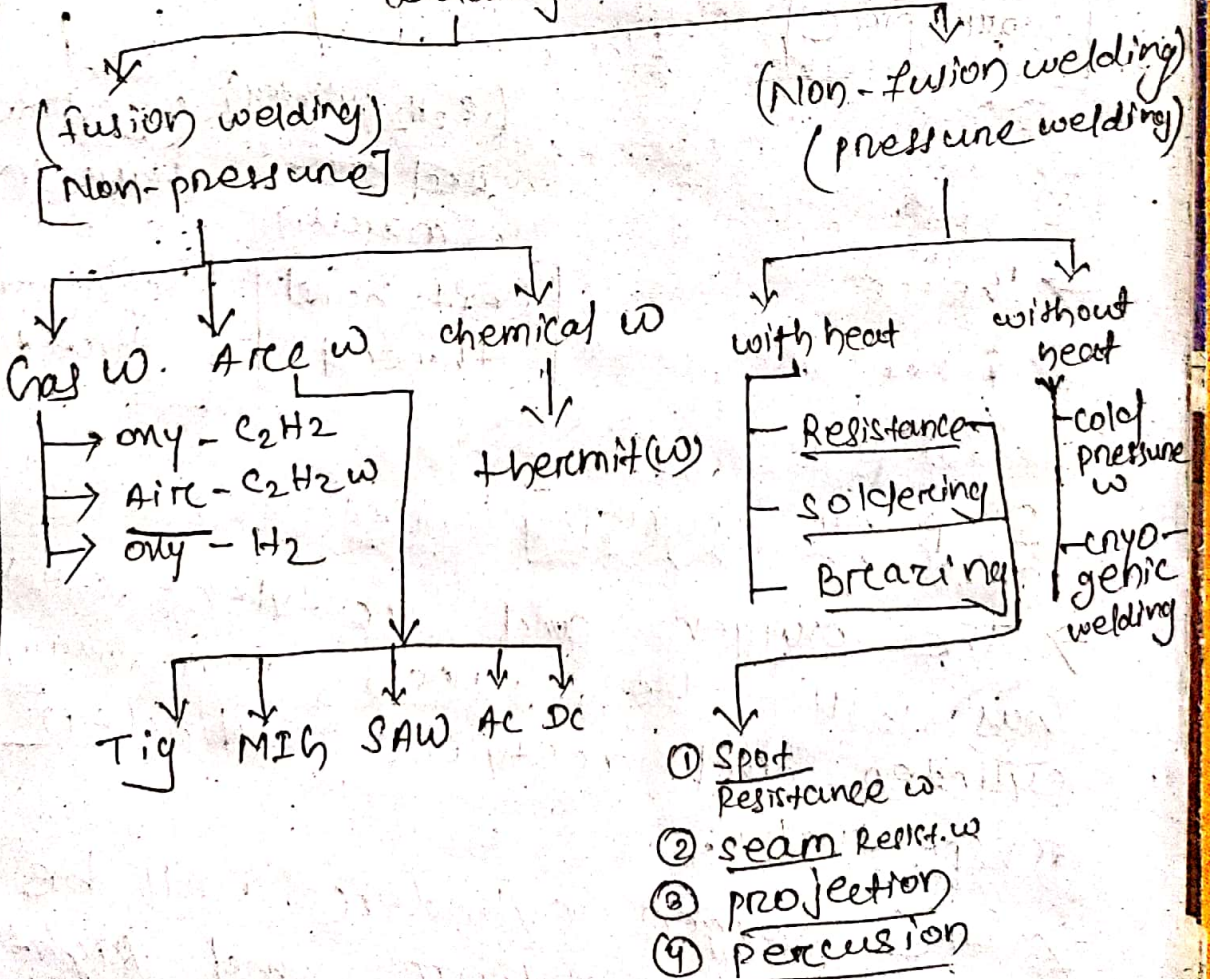
METAL JOINING

* Defination of Metal Joining

Metal joining is a process in which two or more similar or dissimilar metal can be joined by the help of with or without the application of pressure, with or without the application of heat and with or without the application of using filler rood.

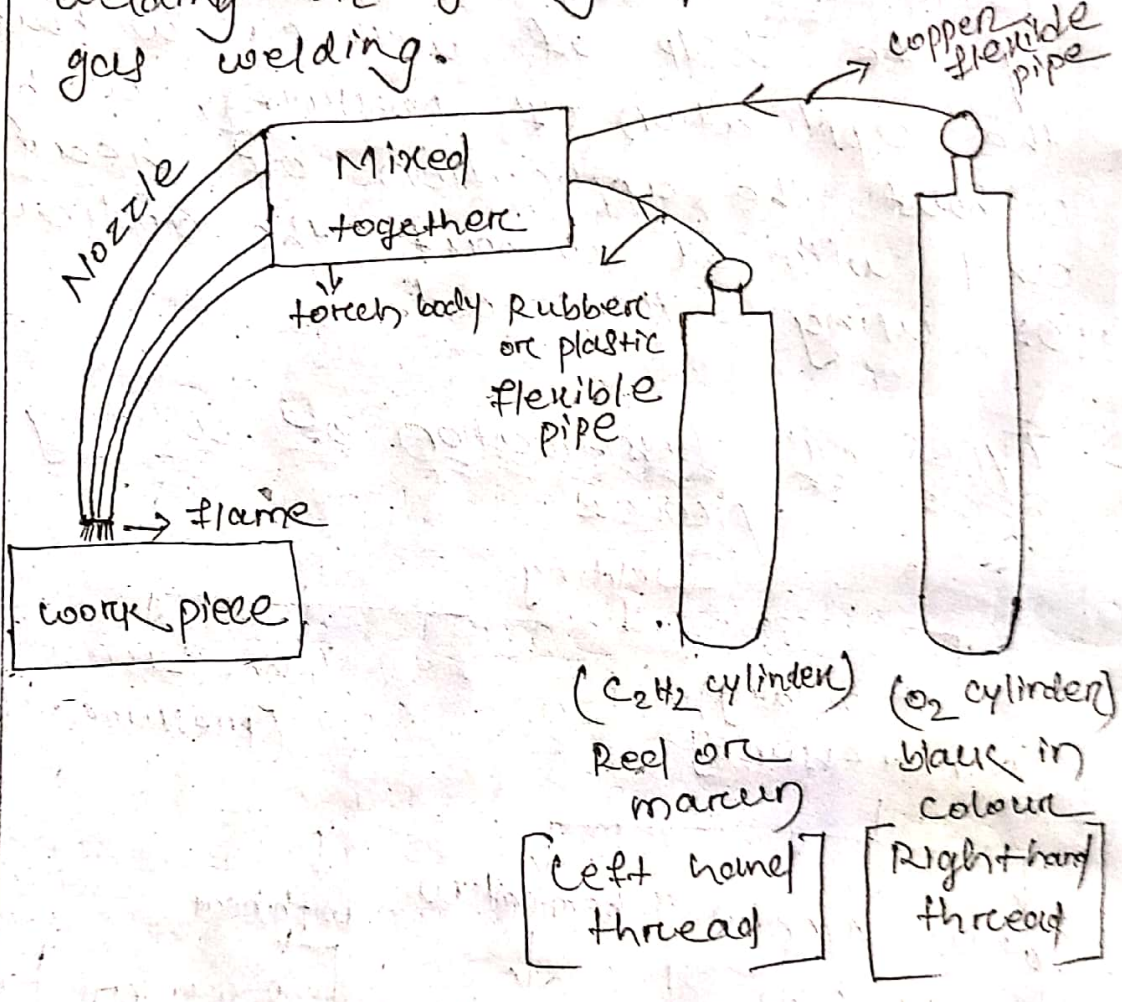
* Types or classification of welding process



Gas welding.

"By burning of gas in presence of oxygen.

If the heat required to obtained welding or joining", is called gas welding.



Step or working principle.

→ The oxygen and acetylene (C_2H_2) Gas will be taken from oxygen cylinder and acetylene cylinder respectively.

→ the oxygen cylinder will be black in colour and Right hand thread similarly the

C_2H_2 Cylinder will be red or maroon in colour and left hand thread condition.

→ the oxygen gas will be go to torch body by the help of copper flexible pipe and the C_2H_2 gas will be goto torch body by the help of rubber or plastic flexible pipe.

→ These gas are taken from flexible pipe and mixed together in the torch body. so that mixture is produce high pressure.

→ when this high pressure mixture is passing through the convergent nozzle, the high pressure energy will converted into kinetic energy. and this K.E will come out from the tip of the nozzle.

→ where that continious flame is produced and heat available in the flame will be used for melting and joining the work piece.

* Equipment used for gas welding:

(i) C_2H_2 cylinder (red or maroon)
(ii) O_2 cylinder (black)
(iii) C_2H_2 gas
(iv) O_2 Gas
(v) Rubber or plastic flexible pipe.
(vi) copper flexible pipe.
(vii) torch body
(viii) convergent nozzle
(ix) work piece.

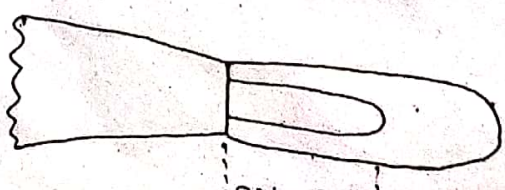
* Different flame produced in Gas welding:

→ there are following type of flame produced in gas welding

(a) Carburizing or reducing flame.
(b) Neutral flame
(c) Oxidizing flame

(a) Carburizing or reducing:

→



{ N = 10-15 mm }

- Length of inner flame is "2N-3N"
- ratio beth C_2H_2 and O_2 i.e

$$\frac{C_2H_2}{O_2} = 1.85$$

- In this flame outer flame is Blue and inner flame is red.
- the maximum temp produced in the flame is 2900°.
- In this flame smoke will be produced.
- used:- welding of medium carbon steel / Nickel.

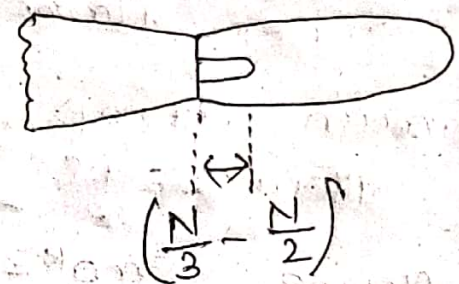
(b) Neutral flame.

Length of inner flame is "N".

- the ratio beth C_2H_2 and O_2 i.e $\frac{C_2H_2}{O_2} = 1$
- In this flame outer flame is Blue and inner flame is ~~white~~ yellow or white.
- the maximum temp produced in the flame is 3100°.
- In this flame smoke will be produced very little.

→ used :- welding of low carbon steel, mild steel, aluminium and cast iron.

(c) Oxidising flame.

→ 

$\left(\frac{N}{3} - \frac{N}{2}\right)$

Length of the inner flame is "$\frac{N}{3} - \frac{N}{2}$"

→ ratio between C_2H_2 and O_2 i.e

$$\frac{C_2H_2}{O_2} = 0.85$$

→ in this flame outer flame is Blue and inner flame is white.

→ the maximum temp produced in the flame is 3300°C.

→ in this flame No smoke will be produced.

→ used :- welding of Brass, Bronch, zinc, copper.

* Advantages.

- No skill persion can be welded by this method. or process.
- It is easily shift from one surface to another surface.
- without electricity, we welded by this method.
- Less manufacturing cost.
-

* Disadvantages.

- High thickness plate or metal cannot be welded.
- Surface finished is not good.

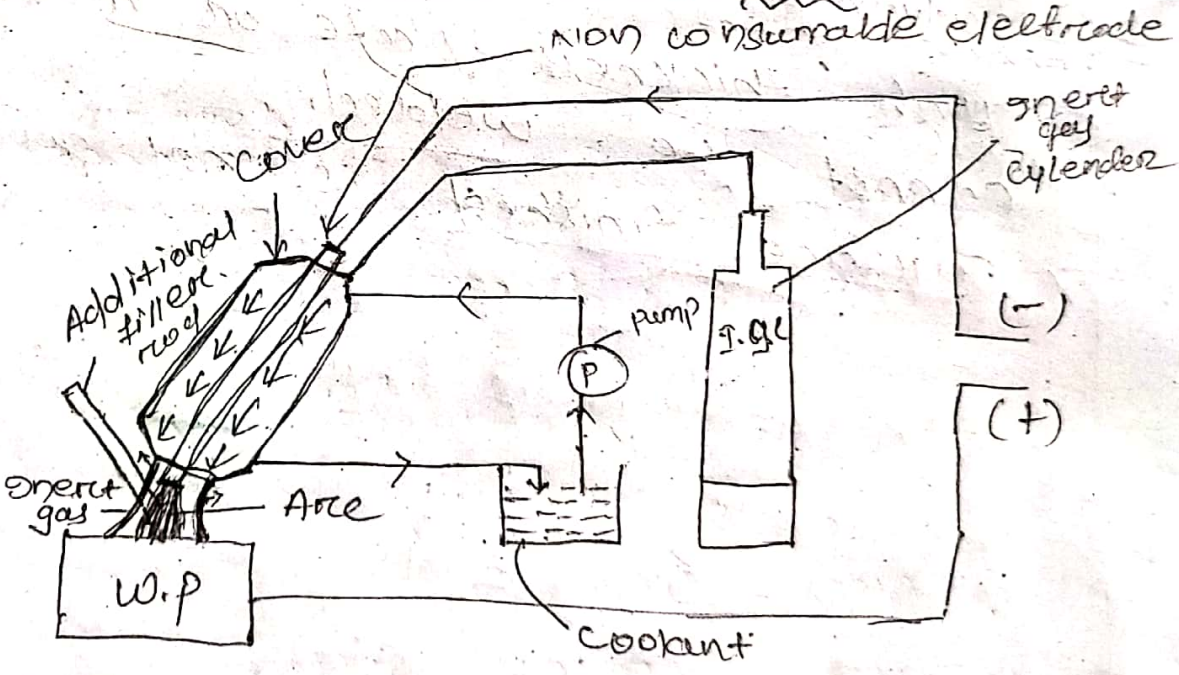
* ARC Welding.

→ If the welding is done by the help of arc is called as arc welding.

→ There are following types of arc welding. they are

1. TIG
2. MIG
3. SAW
4. AC
5. DC

TIG (Tungsten inert gas)



Working principle of TIG welding:-

→ TIG welding is similar to the normal arc welding operation, but it used tungsten electrode as a non consumable electrode.

→ on this welding operation or process, a cover is provided around the non consumable electrode. so that the inert gas is supply to the top of the cover and leaves the bottom of the cover near the tip of the electrode, and moving away from the welding zone, which is prevent the atmospheric contamination.

→ similarly coolant also entry the top of the cover and leaves the bottom of the cover which is keep the temp of electrode as low as possible.

→ on this welding operation positive charge is connecting with the workpiece and negative charge is supply connected with Non-consumable electrode. when power is supply, arc is produced both the top of the electrode and work piece.

→ after that work piece will be melted and joined the parent material.

→ Because (argon) is the most commonly used as inert gas in this process. so it is also called as argon arc welding process.

USES OF TIG Welding :-

- Joining or welding of low carbon steel, high carbon steel or low and high melting point, high reaction metal.
- Joining of aluminium, magnesium, Aerospace industries, Auto mobile industries.
- on this method we welding upto only 5mm thickness metal.

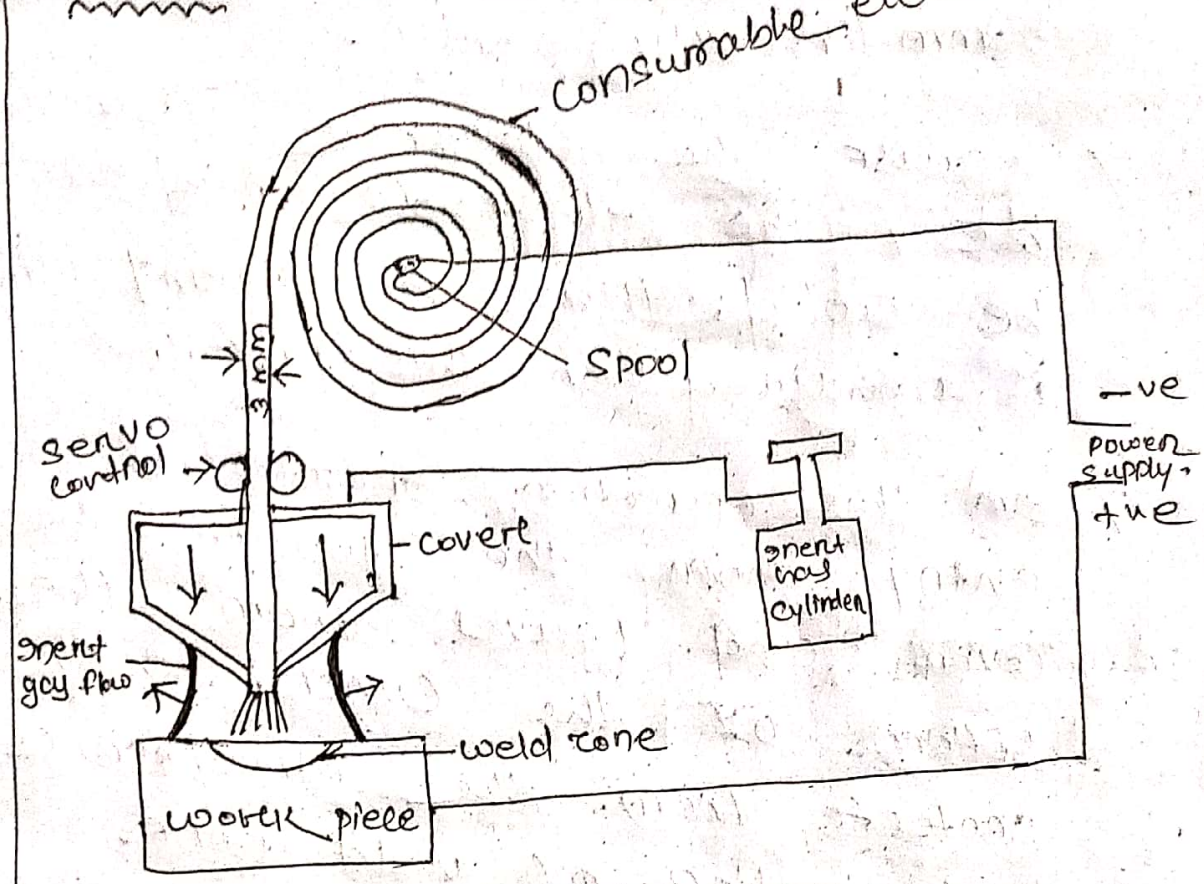
Advantages:

- surface finished of welding is good as compair to gas welding.

Disadvantages

- cost of Tig welding is more because here we pump, coolant
- of above 5mm thickness plate is welding by this process, we must be used an additional filler rod.
- Because of non-consumable electrode it is used for welding upto 5mm thickness only.

* MIG



Working principle

→ To over come the limitation of TIG welding, the MIG welding operation is developed.

→ In this welding operation (+)ve charge is ~~charged~~ connected with work piece and (-)ve charge is connected with consumable electrode.

→ In this welding operation continuous consumable electrode is used which is bounded with spool, and this electrode is controled by servo control.

→ the diameter of electrode is 3 mm (nearly) only.

→ because the electrode is consumable, the electrode need not be cooled. Hence no coolant supply is required on this process.

→ on this operation inert gas is entry from the top of the cover and leaves from the Bottom of the cover, cover is protect from the atmosphere contamination of weld zone.

→ on this operation the arc is produced both tip of the consumable electrod and workpiece.

Advantages,

→ surface finished is good,

→ the cost of MIG welding is less. because the complet absence of coolent, filler rod, coolant pump.

→ on this process upto 30mm thickness plate is welding without use of additional filler rod.

→ Because on this welding operation tungston diffusion is eleminated.

→ filler rod is not used on this process.

Disadvantage:

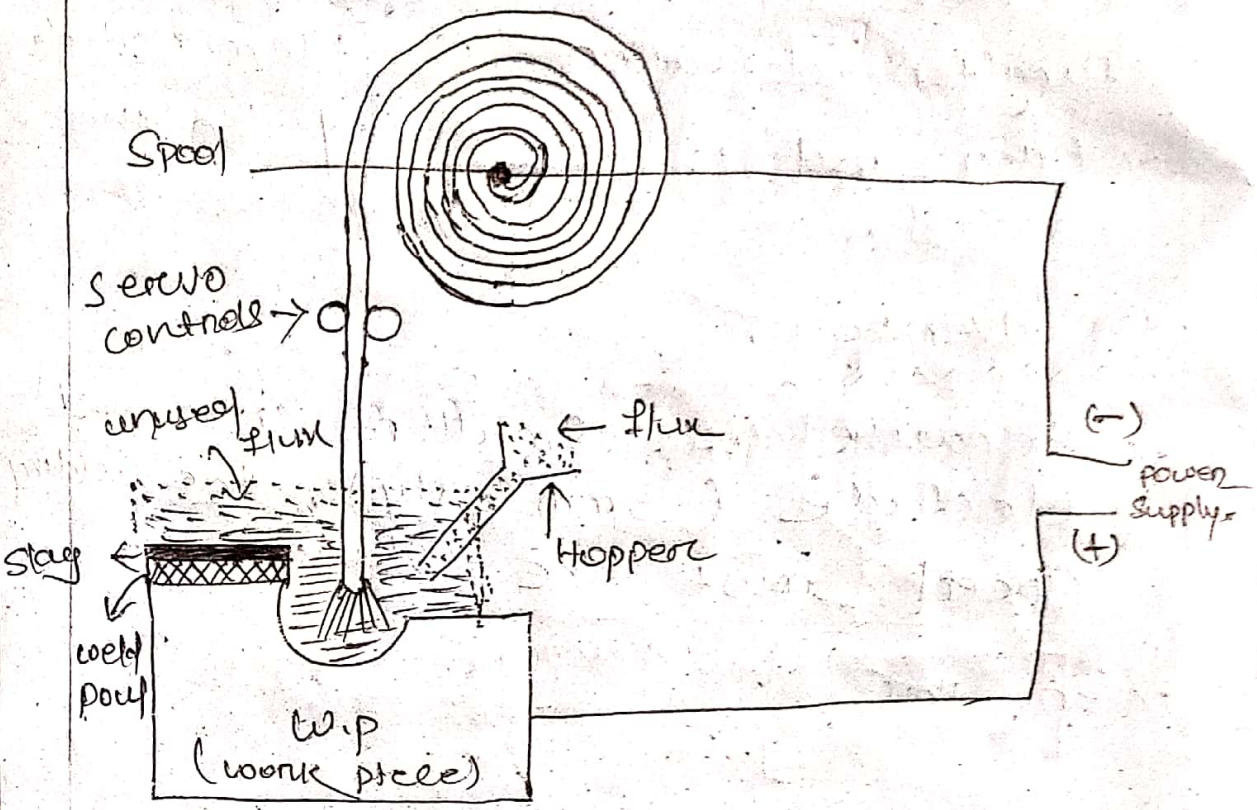
→ Because of smaller size of electrode (3mm only), the welding speed must be slow.

→ on this

Uses:

→ Joining of Aluminium, magnesium, Aerospace industri, Auto mobile industries, copper, nickel, Stainless steel.

* SAW (Submerged ARC welding)



working principle :-

→ The submerged arc welding is similar to the working principle of MIG welding. Here also continuous consumable electrode is used which is bounded around the spool. and it is controled by the servo control.

→ In this welding, on the place of the joint gap, the large quantities of flux powder will be used. which is supply through the Hopper.

→ out of the flux powder some of the getting melting and form slag layer above the welding zone. where as remaining flux powder are floating above the slag layer.

→ on this welding process are will be produced both workpiece and tip of the consumable electrode which is submerged in side the flux powder.

→ Due to large amount of flux powder, the welding zone is completly cover by the flux powder. Hence there is no atmospheric contamination in this process.

→ As the thickness of plate is increases, the quantity of flux powder also increases.

→ in this welding operation the (+ve) charge will be connected with the work piece and the negative charge will be connected with consumable electrode.

Advantages.

→ Surface finishing of welding zone is very good.

→ Joining upto 75 mm thickness plate very easily.

→ In SAW the cost is less as compare to TIG.

Disadvantages.

→ It is semiautomatic.

→ Large amount of flux is waste/use.

(Application / uses)

→ Joining of large diameter pipe.

→ Joining of pressure vessel

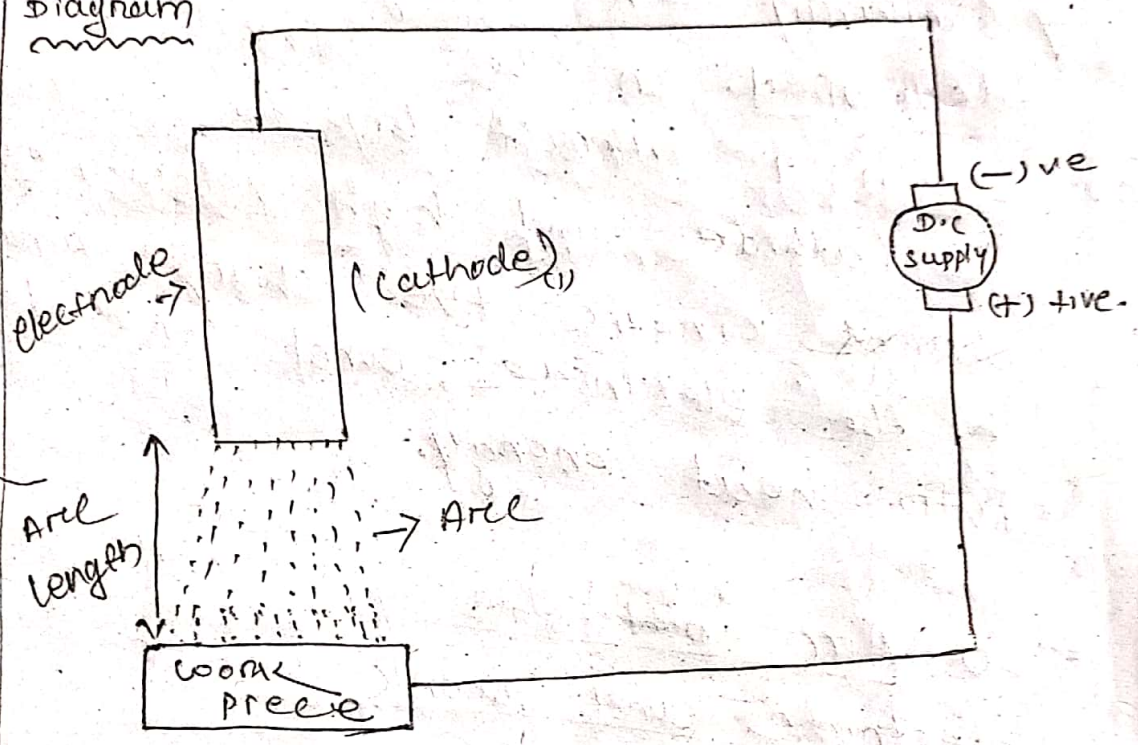
→ Joining of boiler.

→ Joining of ship building.

* Metallic Arc welding:

what ever the joining or melting of plate, or it is obtained by using electric arc is called as Metallic Arc welding operation.

Diagram



Working principle:

→ when power supply is given and optimum gap is maintained b/t the cathode and anode, very high velocity negative charge electrode will be generated at the electrode or cathode, when is attracted by the anode or work piece and moving toward work piece.

→ this high velocity negative charge collide with +ve charge on anode and kinetic energy of electron will be converted into heat energy.

→ similarly +ve charge will be developed on the work piece which is attract by the electrode on cathode and high velocity ~~charge~~ kinetic +ve charge attracted by the electrode and converted into heat energy.

→ So Arc will be produced both electrode and work piece.

→ on this welding heat generated on the cathode is less than anode i.e Cathode : Anode = 1 : 2

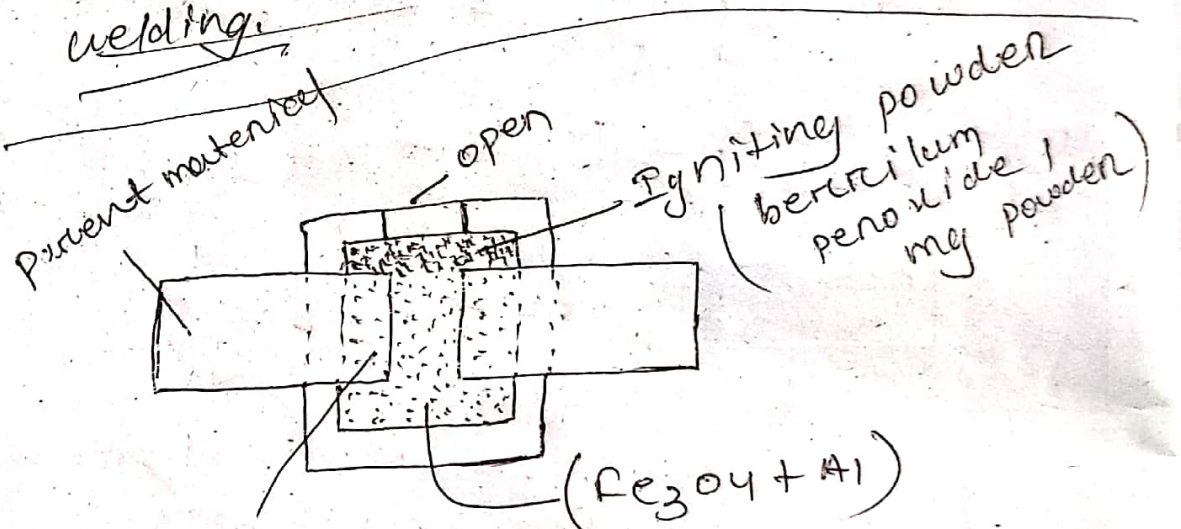
→ the minimum temp produced on this welding process is 5000°C to 6000°C.

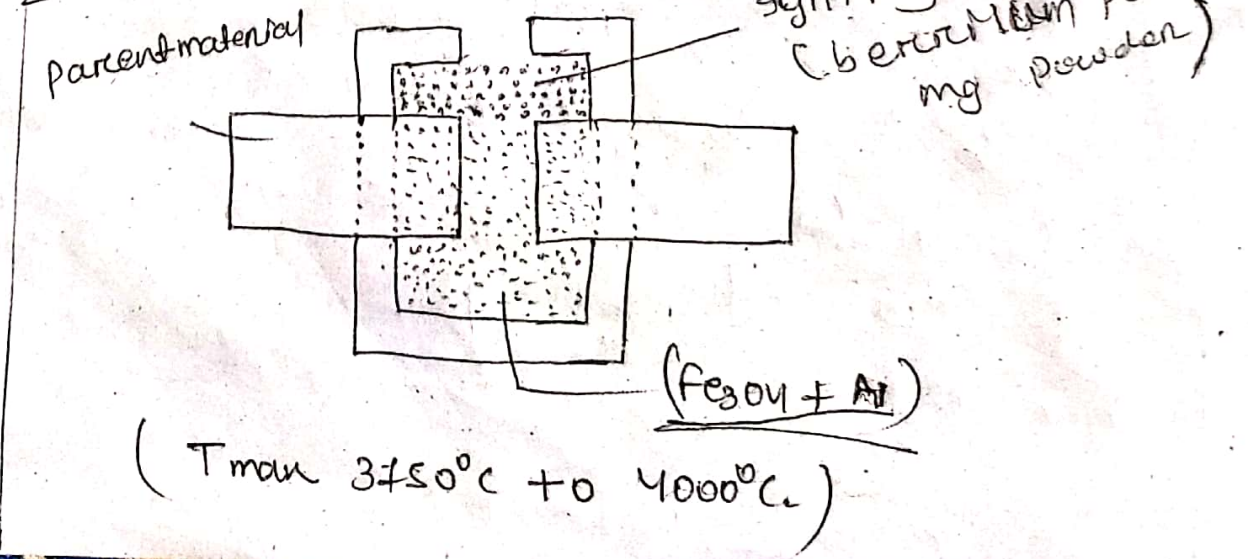
→ due to this high temp U.V rays will be generated during spark zone. If the Arc is seen directly by human eye

the eye will be starting paining. there Zone welding zone must be seen through the safety glass.

Thermit welding.

→ In this process, the heat required for melting on joining of the plate is obtained due to the exothermic chemical reaction of the thermit mixture, hence it is called chemical welding operation on thermit welding.





Working principle:

$Fe_3O_4 + AL \xrightarrow{\text{chemical reaction}} Fe + Al_2O_3 + \text{Heat}$

$Fe_3O_4 + AL$ → thermit mixture

Fe → filler rod

Al_2O_3 → slag

Heat → melting and joining

→ The powder form of Fe_3O_4 (iron oxide) and Al (Aluminium) will be mixed together to form a mixture. It's called as Thermit mixture.

→ This thermit mixture will fill into the joint portion by the help of Box and thin layer of ignition powder will be fill into the top.

→ the most commonly used in ignition powder are barium peroxide and magnesium powder.

→ Due to exothermic reaction, there are 3 product are produced

(i) ~~Filler rod~~ Fe used as filler rod in the welding process.

(ii) Al_2O_3 used as slag for protecting the weld zone

from the atmosphere contamination.

(iii) Heat used for melting and joining of parent material and produced joint.

→ In this welding process maximum temp produced is 3750°C to 4000°C.

Advantages.

→ used for joining necessary track.
→ use for joining large broken crank shaft.
→ used for joining teeth of large gear.
→ used for joining large welding construction.

Disadvantages.

→ High skeel ∧ pension can operate.
→ It can't welding low melting point material.
→ low deposition rate.

Resistance Welding.

→ Resistance welding is a non-fusion or pressure welding process.

→ The heat required for melting of plate is obtained by using electrical resistance of the circuit. Hance it is called resistance welding.

→ Heat generation = I^2RT

where I = Current
R = Resistance of circuit
T = Time during the current passing through the circuit.

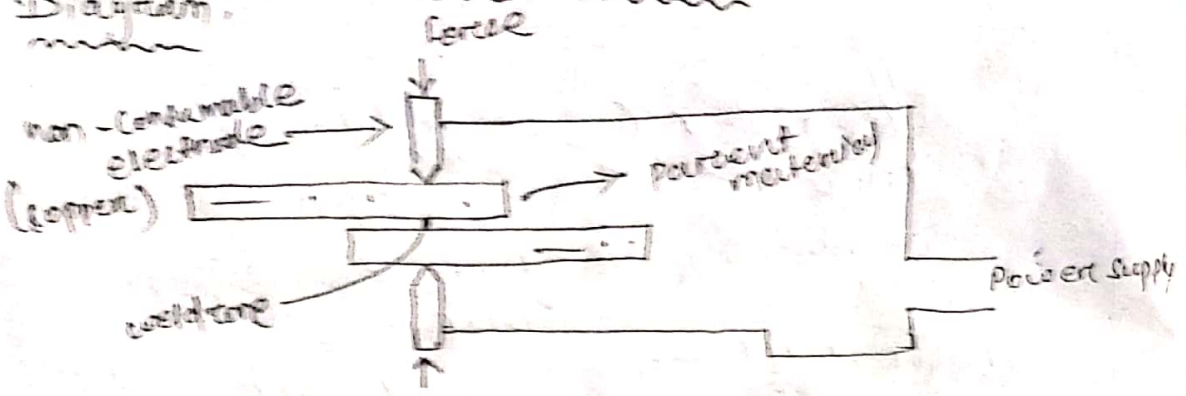
Types of resistance welding.

There are following types of resistance welding.

(I) Spot resistance welding
(II) seam resistance welding
(III) projection
(IV) percusion.

Spot resistance welding.

Diagram.



→ In this welding process consists of non consumable electrode (copper), power supply (transformer), parent material (plate), cooling water etc.

→ when power supply is given to the electrode, the high current and high force produced on the two electrode.

→ this two force are attract each other, after that spot welding will be produced beth the two thin plate.

→ In this welding process high current (10000 Amp) is used.

→ In this welding process (Step down transformer) will be used.

→ In this welding process the time taken for spot welding is 0.01 sec.

→ In this welding process copper electrode are used which are non-consumable.

→ The spot welding is produced by applying pressure.

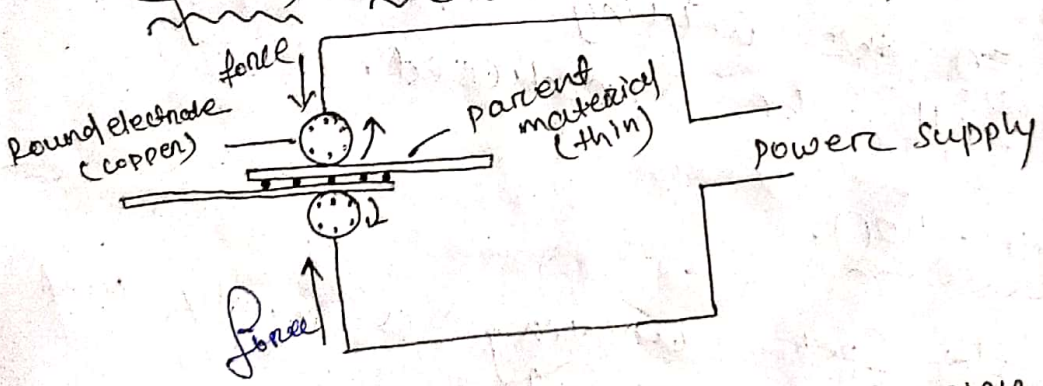
→ In this welding only lab joint will be produced.

Application / used:

→ the spot welding is mainly used for Lab Joint of thin plate/sheet.

→ welding of automobile refrigerator body.

Seam resistance welding.



→ In this welding process consists of two roller electrode (copper), power supply (transformer), parent material (plate), cooling water etc.

→ when power supply is given to the round electrode, the high current and high force is produced on the two round electrode.

→ By the help of two roller, when these roller are moving along the two thin plate and force is apply, the seam welding will be produced.

→ In this welding process high current is used i.e (10000 Amp).

→ In this welding process step down transformer is used.

→ Seam welding is produced by applying pressure.

→ In this welding only lap joint will be produced.

Application.

→ the Spot welding is mainly used for Cab Joint.

→ using of automobile refrigeration body.

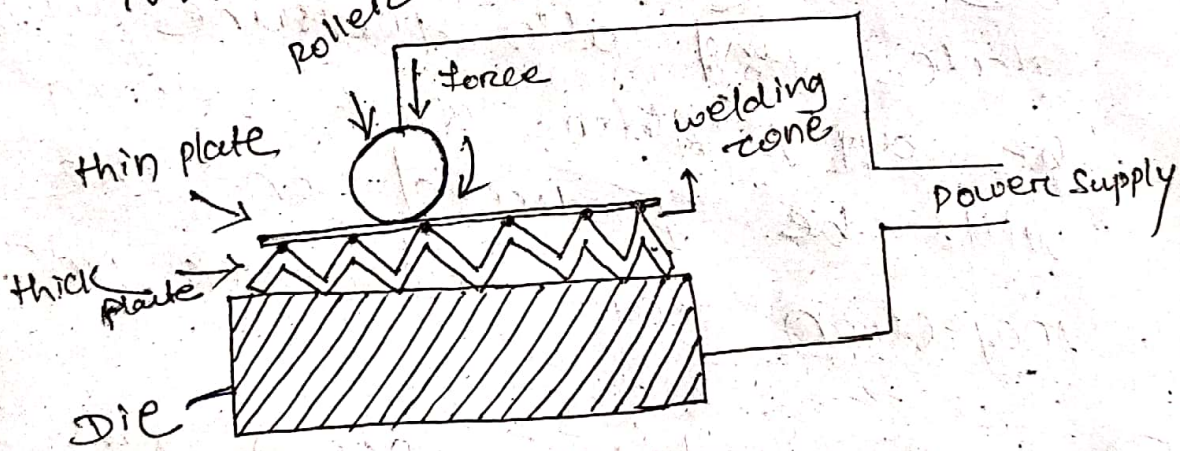
Advantages,

- Lap joint will be produced very easily.

Disadvantages,

- Butt joint will not be produced by this process.
- In this process, high current will be used.

Projection welding,



(1) In this welding process consists of one roller (copper), Die, power supply (transformer), thick plate (projection), thin plate (straight plate), cooling water, force etc.

(ii) on this welding process projection plate will be situated above the die and thin plate is situated above the projection plate and roller will be situated above the thin plate.

(iii) when power supply is given to the ~~roun~~ electrode and die the high current and high force will be produced. then roller will be moving above the thin plate and also pressure will be apply. after that welding will be produced on the projection part of the thick plate.

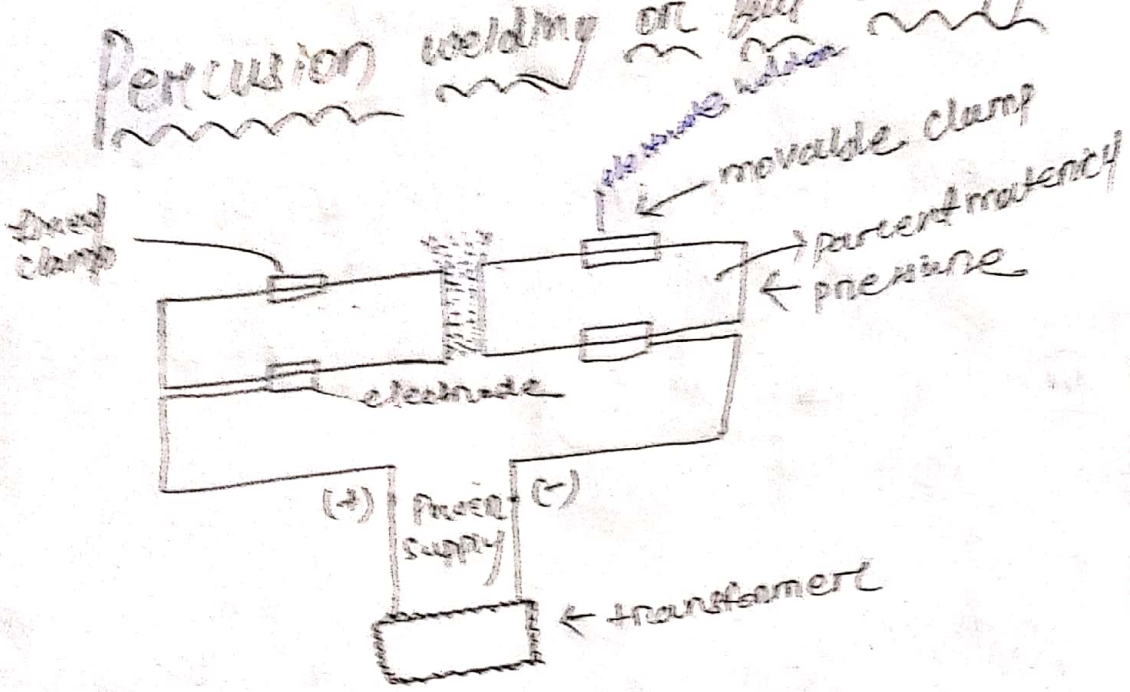
(iv) on this welding process high current is used i.e (10000 Amp)

(v) on this welding process step down transformer is used.

(vi) projection welding is produced by appling pressure.

(vii) on this welding process only lap joint will be produced.

Percussion welding or butt welding:



Working principle

(i) on this welding the workpiece which are welded will be clamp in the electrode holder. out of two electrode one is fixed and other is moveable.

(ii) on this welding +ve charge will be connection with fixed electrode and negative charge will be connected with movable electrode.

(iii) when power supply is given to the two electrode, the moveable electrode is moving towards the fixed electrode.

(iv) After that flash will be generated b/n two parent material. After that parent material will be melt and disconnect the current.

(v) After that axial pressure will be apply of movable material.

(vi) then percusion welding will be generated.

(vii) In this welding current range is 10^5 Amp.

Application.

(i) This welding will be used for Butt Joint, or end to end Joint or edge to edge Joint.

(ii) This welding is used for mild steel, Alloy steel, titanium

Chapter-7:- Metallurgy of welding.

There are following types of welding defect.

A- External defect

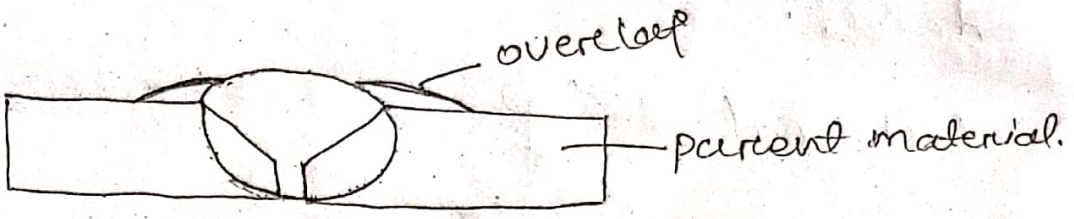
(i) over lap
(ii) under cut
(iii) spatter
(iv) crater
(v) excessive convexity (ex)
(vi) excessive concavity (cx)
(vii) surface porocity
(viii) surface crack.

B- Internal defect

(i) Internal porocity.
(ii) Slag inclusion
(iii) internal crack
(iv) lack of fusion
(v) in complete filling groove.

* External defect:-

(i) overlap



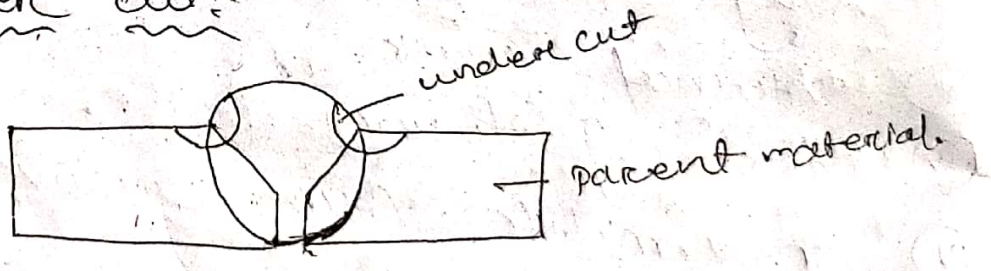
Causes or reason:-

-> use of oversize electrode.
-> use of excessive current.
-> modification of movement of torch angle in gas welding.

Remedies.

-> use of required amount of current.
-> use of a required size electrode.
-> No modification of torch movement

(ii) under cut:-



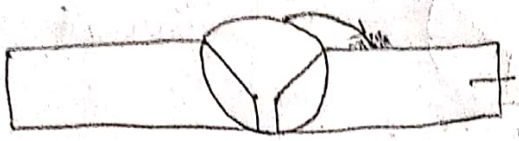
reason:-

-> use of under size electrode
-> No use of filler rode in gas welding.
-> use of damped electrode
-> modification of torch movement.
-> excessive arce length.

Remedies.

→ use of avarage size electrode
→ use of filler rode
→ required amount of arc length

(3) Spatter:-



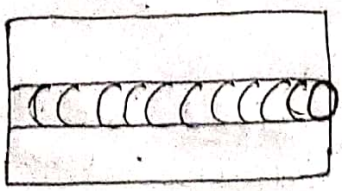
Causes or Reason:-

→ modification of touch movement
→ Low welding speed in gas welding.
→ use of damped electrode.
→ excessive arc length.
→ Joining of high reaction metals.

Remedies:-

→ required arc length

(4) crater:-

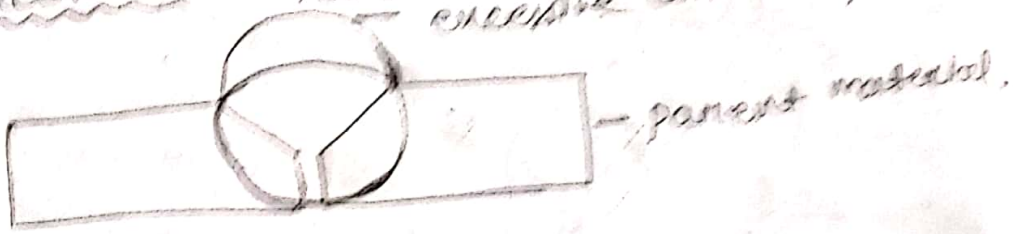


Causes or Reason:-

→ on correct touch angle or modification of touch angle at the end of welding.

Remedies:-
→ No change of current angle during actual welding process.

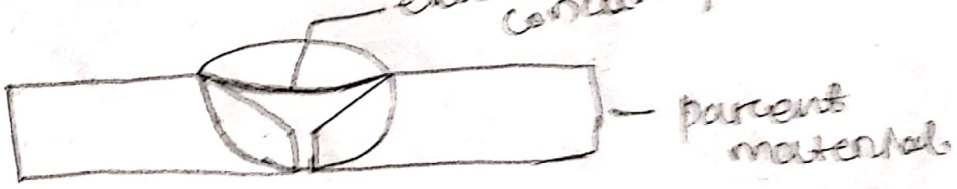
① Excessive convexity:-



Causes or reason:-
→ use of excessive current.
→ use of oversize electrode
→ low welding speed in gas welding.

Remedies:-
→ required current will be used.
→ proper size electrode will be used.
→

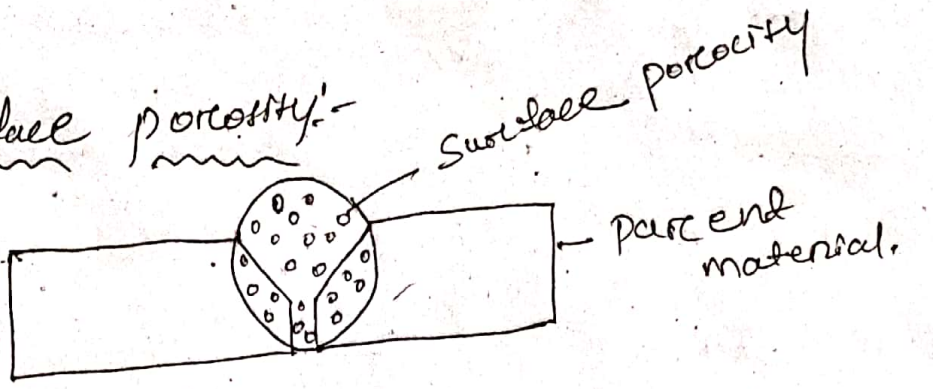
② excessive concavity:-



Causes or reason:-
→ use of under size of electrode
→ No use of filler rode
→ excessive arc length.

Remedies:-
→ proper size electrode will be used.
→ filler rod will be used.

⑦ Surface porosity:-



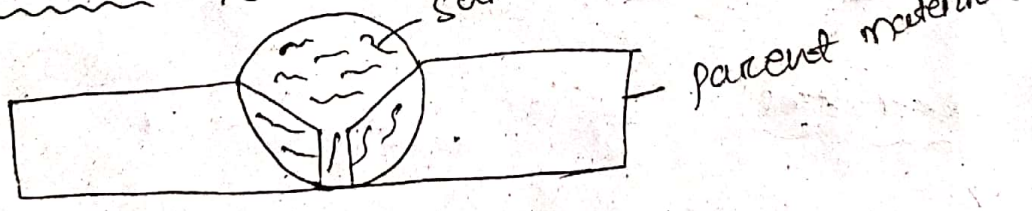
Causes or reason:-

→ Joining of dirty of welding surface with out pre heating.
→ use of damped electrode.
→ gas welding with out use of flux.

Remedies:-

→ obtaining good surface finish before welding
→ use of flux during gas welding.

⑧ Surface crack:-



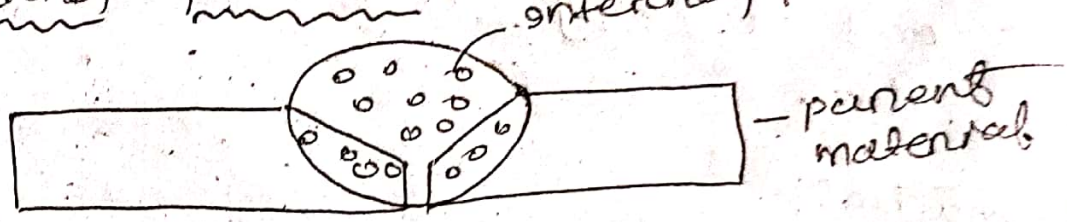
Causes or reason:-

→ use of damped electrode for joining of ferrous material.
→ Joining of high expension metal with out preheating.
→ Joining of ferrous material.

- Remedies!-

* Internal defect!-

(i) Internal Porosity!-



Causes or reason!-

→ Joining of dirty of welding surface with out pre-heating.

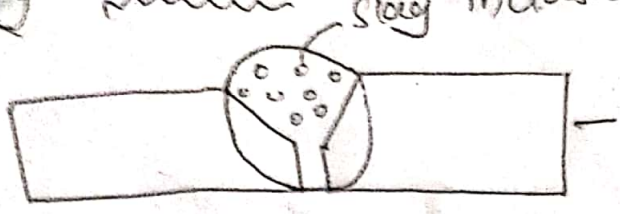
→ use of damped electrode.

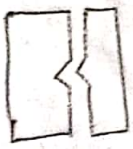
→ gas welding with out use of flux.

Remedies!-

→

② Slag inclusion:-





Causes or reason

- Incorrect Joint collection.
- use of fore-hand welding technique.
- improper collection of flux in gas welding.
- improper cleaning of weld bit.
- Discontinuous of welding.

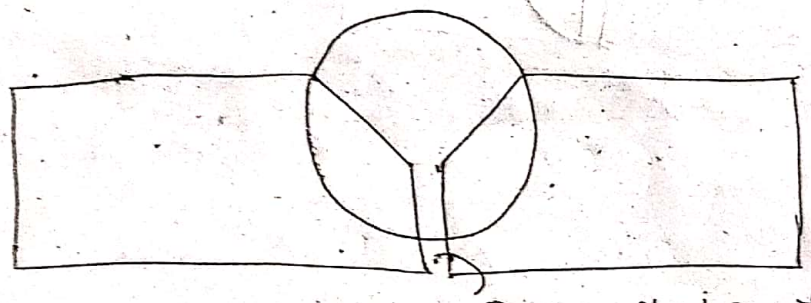
③ Internal crack:-

④ Lack of fusion:-

Cause or reason

→ Insufficient current condition.
→ Joining of dirty surface with out pre heating.
→ Incorrect touch angle in gas welding.

⑤ Incomplete filled groove:-



Incomplete filled groove

Cause or Reason:-

→ Welding of large metal with small root gap.
→ Insufficient current condition.
→ Joining of dirty surface with out pre heating.
→ In correct touch angle in gas welding.

* Brazing and Soldering * Chapter-3

"Soldering" is defined as the group of joining process with or without the application of pressure is produced by heating at suitable temperature and using filler rod metal having melting point (not greater than) 427°C.

Basic step of Soldering of common metal:

(i) selection of the proper joint and clearance.
(ii) selection of right flux and filler rod metal.
(iii) cleaning the surface where we joint.
(iv) flux and filler rod are in proper placement.
(v) Heating the joint of soldering temperature (<427°C) for optimum time.
(vi) then the solder is cooled.
(vii) then the solder joint is clean (Remove the slag layer produce during soldering)

Various type of solder or filler metal:-

① Lead - tin solder:-

Lead (Pb) - 95%
tin (Sn) - 5%

(i) Lead tin solder are use for various joint of metal.

(ii) It is good corrosion resistance.

② Lead - tin - antimony:-

Lead (Pb) - 67%
tin (Sn) - 31%
antimony (Sb) - 2%

(i) Addition of antimony to increase the mechanical strength of this solder.

(ii) It is good corrosion resistance.

(iii) It is use for soldering iron and steel.

③ Tin - zinc solder:-

Tin (Sn) - 91%
zinc (Zn) - 9%

(i) This solder is use for joining aluminium.

(ii) It is good corrosion resistance.

④ zinc - cadmium solder:-

zinc (Zn) - 17%.

cadmium (Cd) - 83 %.

(i) this solder is also use for joining aluminium.

(ii) It is good corrosion resistance.

⑤ zinc - aluminium solder:-

zinc (Zn) - 95%.

Aluminium (Al) - 5%.

(i) this solder is also use for joining aluminium.

(ii) It is good corrosion resistance.

(iii) the joint produce is high strength by this solder.

⑥ tin - indium solder:-

Tin (Sn) - 50%.

Indium (In) - 50%.

(i) this solder use for joining glass to glass and metal to glass.

Brazing.

→ Brazing is defined as the group of joining process with or without application of pressure is produce by heating a suitable temperature and using filler rod metal having melting point greater than 427°C.

→ the filler metal is distributed sets two welding zone by the capilary motion of capillary attraction.

Principle of brazing:-

→ the melting point of filler metal is less then the melting point of parent material or base material.

→ capeillary flow of filler metal is major role for welding.

→ High fluidity of molten filler metal is also important for joint.

Basic step / procedure of brazing.

→ selection of the proper joint and clearance.

→ selection of right flux and filler metal.

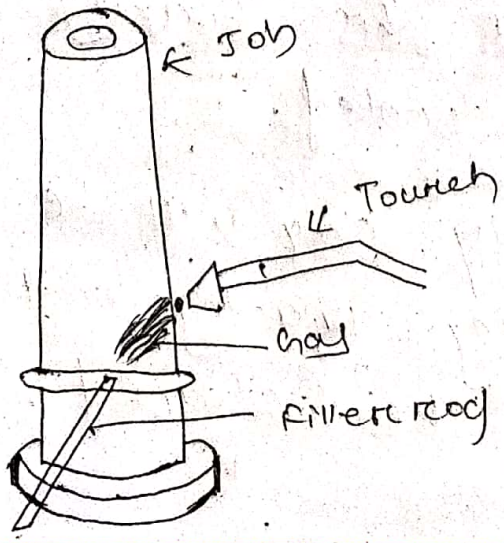
-) Cleaning the surface where we joint.
-) flux and filler node are in proper placement.
-) Heating the joint of brazing temp (> 427°C) for optimum time.
-) then the brazing is cooled.
-) then the brazing joint is clean (remove the slag layer produce during brazing).

Brazing Method

⇒ their are following type of brazing method

(i) Touch method.
(ii) induction method.
(iii) vaccum method.

Touch method.



Procedure/ working principle/ step

(i) The Torch brazing method is the most versatile method and it is used in wide Application in industry.

(ii) In this method heat is usually provide by the Gas welding. which is combination of oxygen and acetylene.

(iii) In this process, Filler rod must be used which clearance is 0.05 to 0.125 mm.

(iv) During torch brazing method, the brazing part must be cleaned and proper selection of flux filler rod are used. then heat is apply as per requirement.

(v) After this Brazing will be done and cooled.

(vi) Finally slag will be produced during Brazing and this slag will be cleaned.

Advantages.

(i) Initial cost of equipment are low.

(ii) It is very flexible process

Disadvantages -

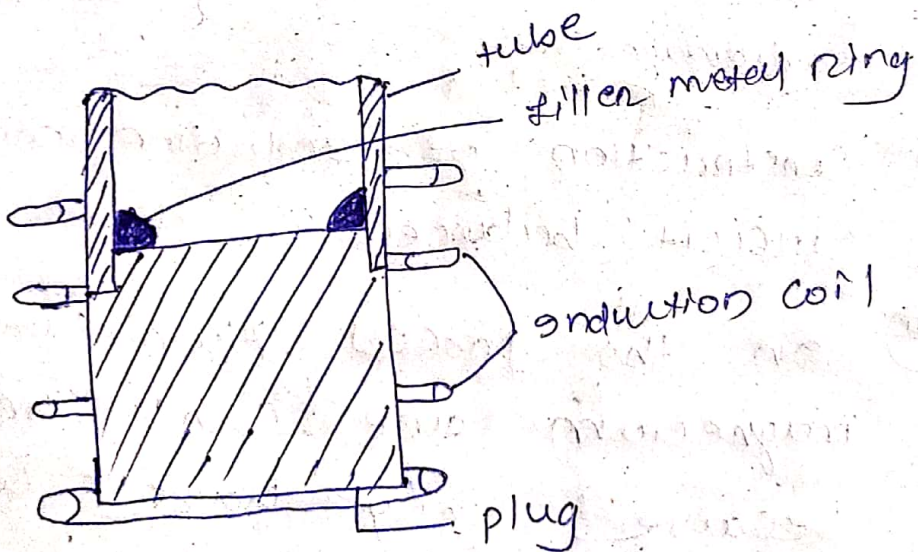
(i) This method is very slow.

(ii) Flame can't be easily apply.

Application.

(i) It is used in Automobile industries

Induction Brazing method.



Working principle.

(1) In induction brazing, it is used where very rapid heating is required and production rate is high.

(2) In this brazing method, filler metal is ring type or ring shape.

(3) In this brazing method high frequency current is used i.e upto 10,000 Hz. by the help of motor generator.

(4) When high frequency electric current is passed through the induction coil, high heat will be produced.

(5) After that, that heat will be brazing the metal. or joint the metal.

Advantages.

(1) the production rate is high.
(2) less skill person can be operate.
(3) high melting point metal will be brazing.

Disadvantages-

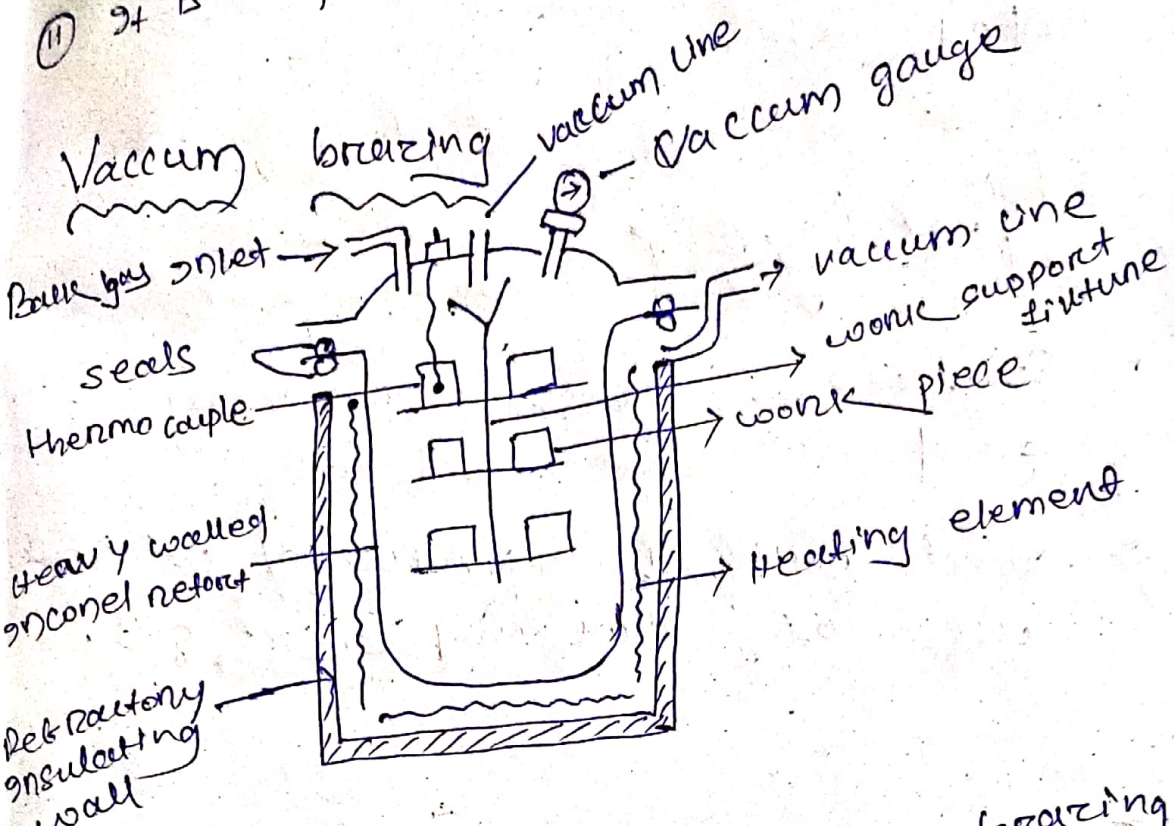
(1) Construction of induction coil and circuit balanced is difficult.
(2) In this process Aluminium and magnesium are can't be braze. because they have low melting point.

Application:-

(1) most of the metal and alloy can be braze by this process except Aluminium and magnesium.

(11) It is used in automobile industries.

Vaccum brazing



⇒ The vaccum brazing is a brazing which is done in the absence of air or atmosphere.

⇒ In this brazing, the vaccum is created by the help of vaccum gauge and air will be removed through vaccum line.

⇒ the vaccum brazing is operated at the temp at 1100° c.

⇒ In this brazing flux is not used (inert gas) to obtained the joining in brazing.

⇒ In this brazing, it consist of vaccum gauge, vaccum line, work piece, Heating element, Refractory

insulating wall, thermocouple, Bulleys, inlet etc.

Advantages:-

→ Surface finished is very good

→ Joint will be produced without use of flux and inert gas.

Dis advantage

→ the furnace is limited in size, so limited size of metal or non-metal can be Joining on brazing

→ No skill person cannot be operate.

→ High melting point metal can't be joint on brazing.

Application.

→ Joining of steel which containing chromium, silicon.

Chapter - 7

Various methode for testing welding Joint.

method

⇒ The testing \ of welding joints are following.

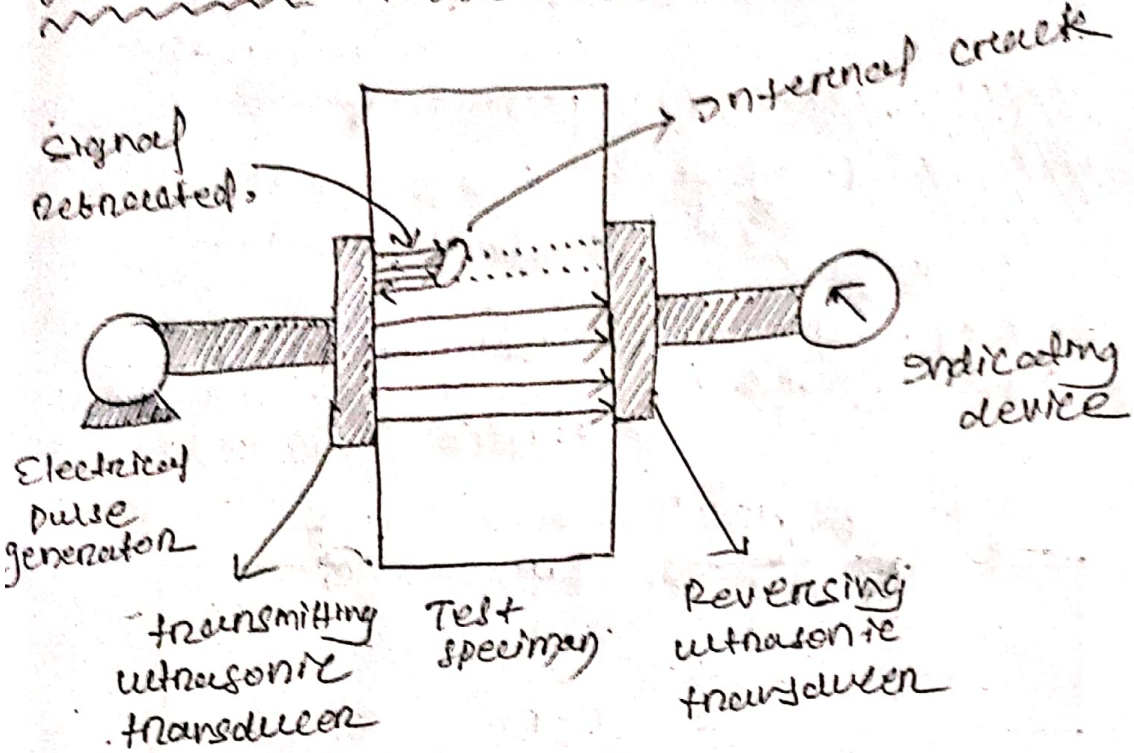
(A) Destructive test

- (a) impact
- (b) tensile
- (c) Izod
- (d) charpy
- (e) fatigue
- (f) creep

(B) Non-destructive test

- (a) X-Ray and Y-ray radiography.
- (b) ultrasonic inspection.
- (c) Dye penetration inspection.
- (d)

Ultrasonic inspection:



→ the ultrasonic inspection methode is consist of electrical pulse generator, transmitting ultrasonic transducer, receiving ultrasonic transducer, indicating device.

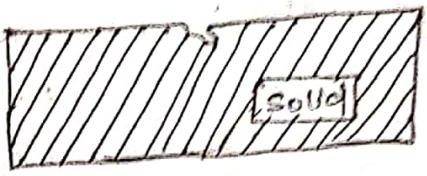
→ When generation is start signal or wave are generated in transmitting ultrasonic transducer and they are go to the receiving ultrasonic transducer.

→ when electrical signal or wave are on straight line, there is no deffect.

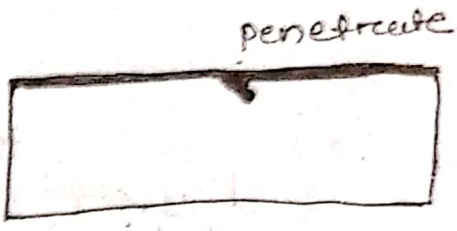
→ where electrical signal or wave are reflected, there is deffect will be found.

→ indicating device is indicate the diffect of material.

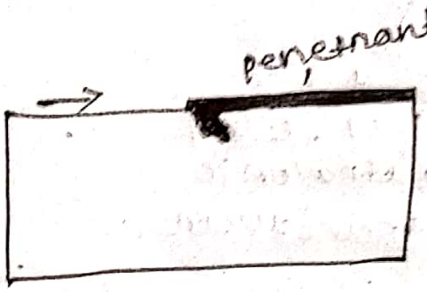
Dye penetration inspection:-



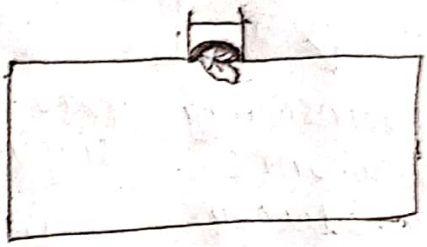
step 1
cleaning and drying of test surface



step 2
Application of penetrant to the test surface.



step 3
remove of penetrant from the test surface



step 4
application of developer.

Working principle

→ In dye penetrant inspection, a liquid or fluorocent is use for penetration so it is called liquid or fluroscent penetrant inspection.

→ In this penetration we first cleaning and drying the test surface

→ After that penetrant the fluroscent above the test surface.

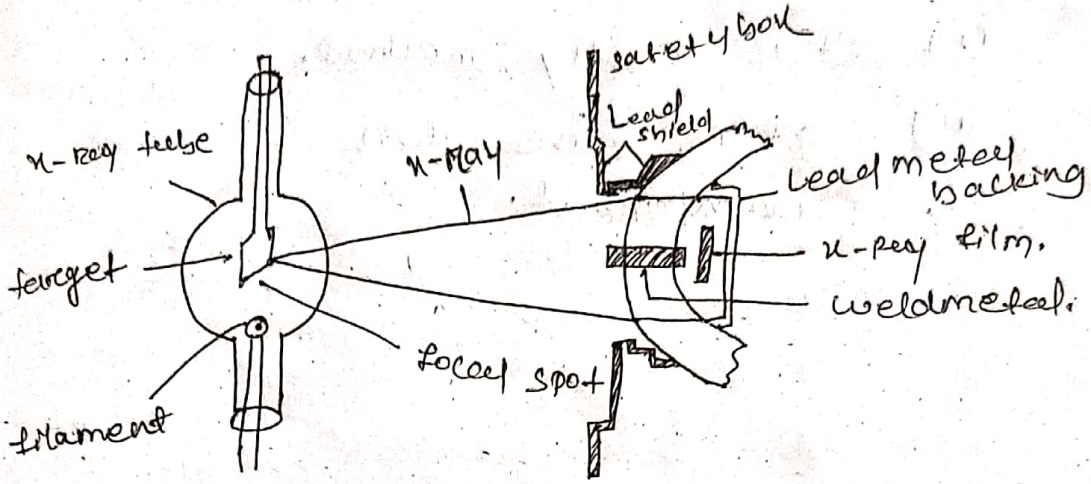
→ After some time remove the fluroscent liquid from the test surface.

→ After some time we see the fluroscent liquid is developed

where crack is present.

- this inspection is use for both ferrous and non-ferrous metal.

X-Ray radiography:-



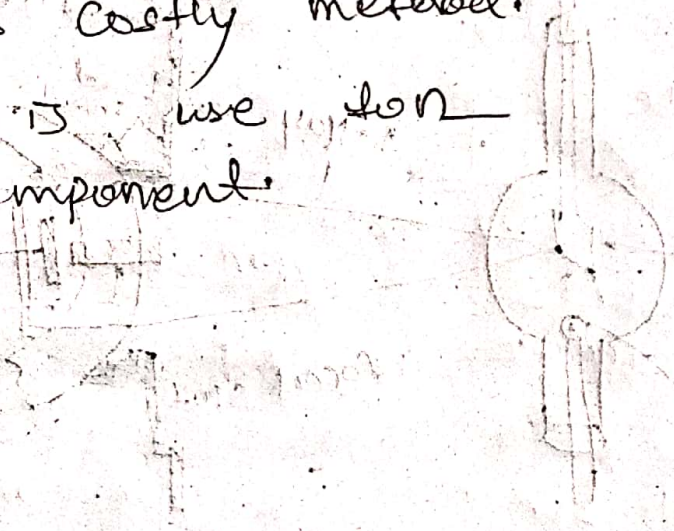
- By passing x-ray through the welding zone, the radiography film will be obtained base on the colour variation in the film the present of defect will be estimated.
- If the film is uniform colour indicate that defect in the presence of welding zone
- If a dark or black colour is observe, the film indicate no defect. or high density inclusion.
- If a pure white colour is observe the film indicate blow hole.
- the light white colour indicate low density inclusion.

→ the x-ray method is very accurate method.

→ this method gives the exact details of defect, but limitations are,

(i) it is costly method.

(ii) it is use, non component.



3.) Weldability

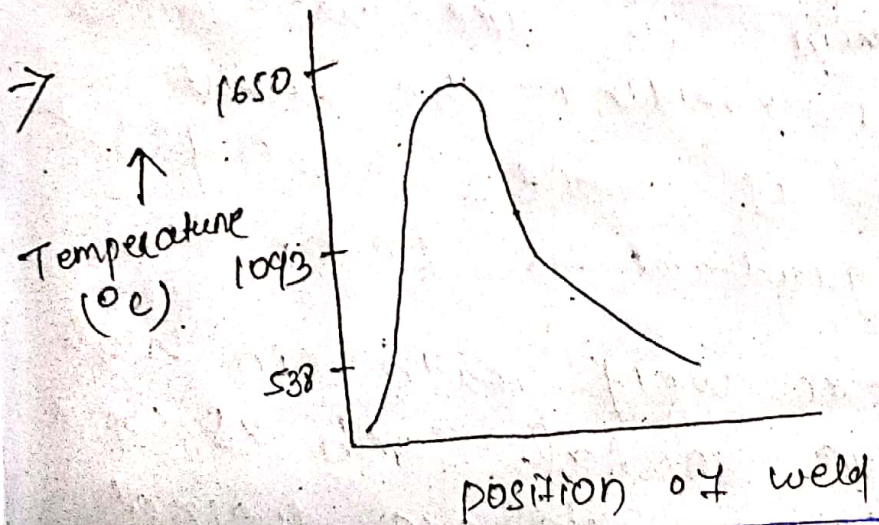
→ weldability is the capacity of a material to be welded under the fabrication condition on joining condition into a specific suitable design condition.

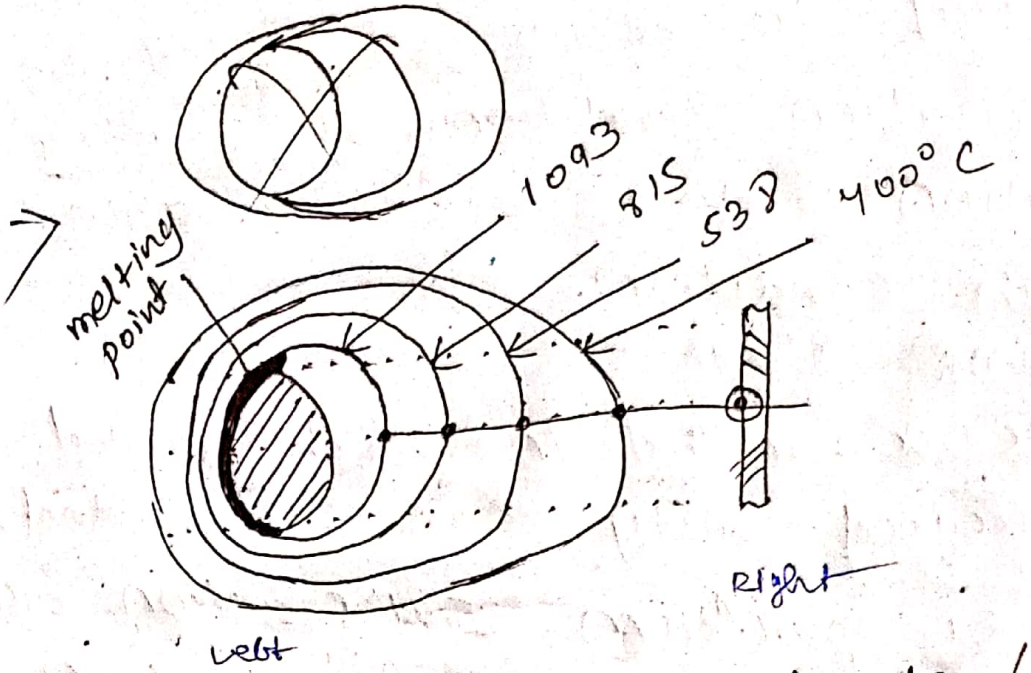
→ It is a method in which metal with good ability can be welded. so it perform satisfaction or required in the fabrication structure.

Temp distribution in the welding of steel.

→ The temp distribution of welding of steel is the flow chat between temp and position of weld.

→





→ cones welding from right to left, the temp also increases from right to left.

→ the leading edge of temp. will be compress. where as the lagging edge of temp the welding cone will be expand.

→ as compair to arc welding, in the gas welding the parent material is more heated but temp gradient is less.

→ the arc weld made in high conductive metal. such as copper alluminium. which are doesnot

produce sleep temp during welding of steel.

CHAPTER - 6

Welding of steel, cast iron, copper iron.

Precaution required for welding of steel.

(i) use of helmet during welding, welding helmet protect the U.V ray and hot slag.

(ii) use fire resistance cloth.

(iii) use safety shoose and gloves during welding.

(iv) use ear protection during welding.

(v) use respiration during welding, the respiration protect from oxide creat during welding process.

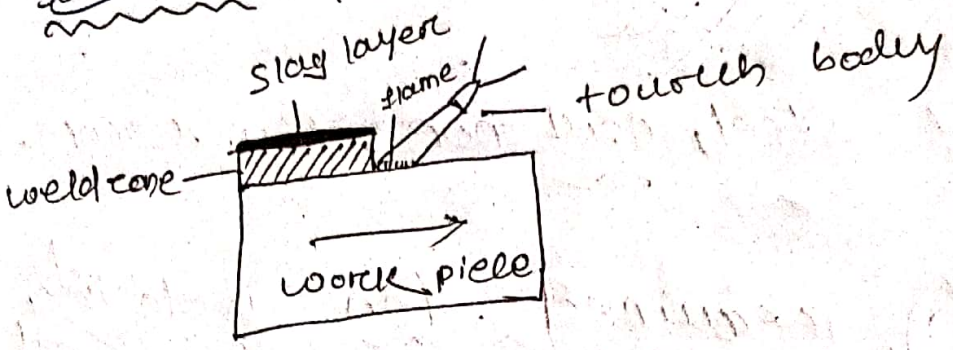
Technic required for welding.

there are mainly 2 type of welding technic.

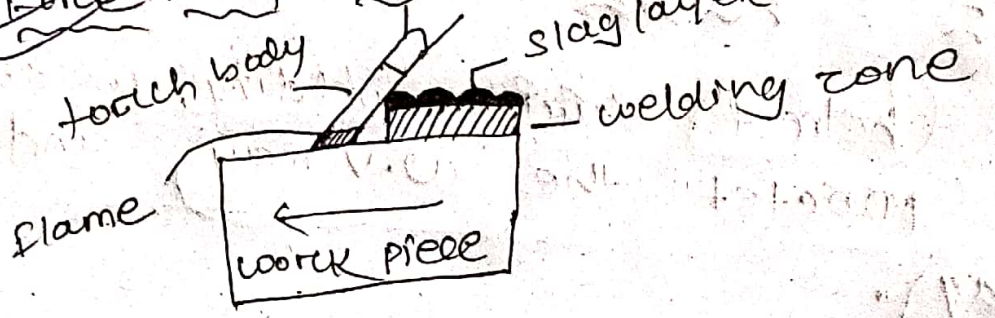
(i) Backhand welding technic or righthand welding technic.

② Forehand welding technic. or
Left hand welding technic.

Back hand technic :-



Fore hand technic :-



(i) If flame is focus towards the already welded portion is called as Back hand welding technic. (or the flame is focus towards the non-welded portion is called as forehand welding technic)

Welding of Copper and its alloy :→

Chapter → 6

(i) On manufacturing, copper is often joined by welding. The Arc welding processes are of Primary concern. Arc welding can be Performed using shield metal arc welding, Gas-tungsten arc welding, Gas-metal arc welding, Plasma arc welding and Submerged arc welding

(ii) Arc Welding Processes

(a) Copper and most copper alloys can be joined by arc welding.

(b) Argon, helium or mixtures of the two are used as shielding gases for GTAW, PAW, and GMAW.

(c) Generally argon is used when manually welding material less than 3 mm thick.

(d) covered electrodes for SMAW of copper alloys are available in standard sizes ranging from 2.4 to 4.8 mm.

(iii) Gas - Tungsten Arc Welding :—

(a) Gas-tungsten arc welding is well suited for copper and copper alloys because of its intense arc, which produces an extremely high temperature at the joint and a narrow heat affected zone.

(b) Many of the standard tungsten or alloyed tungsten electrodes can be used in GTAW of copper and alloys.

(iv) Gas-metal arc welding :—

(a) This welding is used to join of Copper and Copper alloy for thickness less than 3 mm, while GMAW is preffered for section thickness above 3mm.

and joining of aluminium bronzes, Silicon bronzes and copper nickel alloys.

(V) Plasma arc welding :-

(a) The welding of Coppers and Copper alloy using PAW is Comparable to GTAW of these alloys.

(b) Argon, helium or mixtures of the two are used for welding of all alloys. Hydrogen gas should never be used when welding Copper.

(VI) Submerged Arc Welding :-

(a) The welding of thick gage material, such as Pipe formed from heavy plate, can be achieved by continuous metal arc operation under a granular flux.

(b) Effective de-oxidation and slag metal reactions to form the required weld metal Composition are Critical and the SAW Process is still under development for Copper base materials.

(c) Commercially available fluxes should be used for the Copper-nickel alloys.

Chapter → 7

The structure change in weld metal and Parent metal after welding :→

(i) After welding, the sheet metal goes through heating Process, hardening and tempering.

(ii) The first step, hardening, includes a heating of sheet metals over the Ac3 - temperature and a Subsequent fast cooling with a speed of 40-50 k/s.

(iii) The quenched structure is developed from martensite and bainite with a disproportionately high carbon Content.

(iv) In the Second Step, the sheet metals are heated to the transformation temperature AC1. The process is referred to as tempering.

(v) The existing structure of martensite and bainite thereby Separates finely distributed Carbide.

(vi) At the end of the two Process, the sheet metas have tempered Carbon-Poor martensite and tempered fine-grained bainite.

Chapter → 8

* difference between Soldering and brazing?

Soldering	brazing
→ The melting point temp of filler material is less than 427°C and it is also less than melting point temp of base metal.	→ The melting point temp of filler material is more than 427°C and it is also less than melting point temp of base metal.
→ Filler metal is an alloy of lead and tin. It is known as solder.	→ Filler metal is an alloy of copper and zinc, copper and silver, copper and aluminium.
→ The fluid used in solder is zinc chloride ($ZnCl_2$) and hydro chloric acid (HCl)	→ The fluid used is borax and boric acid.
→ The strength of joint is less as compare to brazing.	→ The strength of joint is more as compare to soldering
→ The soldering is used in electric industries.	→ The brazing is used in pipe fitting where leak proof joint are require.
→ In this welding filler metal is used.	→ In this welding also filler metal is used.